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Space Shuttle Program Return to Flight



CAIB Report

• The Columbia Accident Investigation Board (CAIB) issued Volume I of its Final Report on August 26 – 207 days after the accident

- 15 Return to Flight and 14 Long-Term actions
- 138 Findings
- 27 Observations

• Report Recommendations fall into three areas:

- Requirements for returning safely to flight
- Systemic cultural and organizational issues
- Technical excellence

• Volumes II to VI were released on October 28

- NASA has incorporated responses to these volumes into our RTF efforts and our Implementation Plan



NASA's Implementation Plan for Space Shuttle Return to Flight and Beyond

• The *Implementation Plan* is a living document that is regularly updated to reflect our progress on returning safely to flight

- Revision 2, the fourth iteration of the Plan, was released this week

• It is a communication tool to keep all Space Shuttle Program stakeholders informed of our status

• It includes NASA's response to:

- All CAIB Recommendations and Observations, both RTF constraints and long-term actions
- Space Shuttle Program Raising the Bar actions



Copies of the plan are available at www.nasa.gov

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Space Shuttle "Raising the Bar" Actions

In addition to the CAIB actions, the Space Shuttle Program generated a series of additional items that must be addressed to improve Shuttle safety and reliability

• SSP-1 Assess Quality Planning Requirements Document (QPRD) and Government Mandatory Inspection Point (GMIP) criteria

• SSP-2 Evaluate public risk

• SSP-3 Evaluate Contingency Shuttle Crew Support

• SSP-4 Review "Accepted Risk" hazards

• SSP-5 Analyze critical debris sources, transport modes, and impact areas

• SSP-6 Review all waivers, deviations, and exceptions

• SSP-7 Consider all NASA Accident Investigation Team (NAIT) findings, observations, and recommendations

• SSP-8 Improve Certificate of Flight Readiness (CoFR) process

• SSP-9 Review and verify Failure Mode and Effect Analyses (FMEAs) and Critical Items Lists (CILs)

• SSP-10 Review and update Program-, project-, and element-level contingency plans

• SSP-11 Remove and inspect rudder speak break actuators

• SSP-12 Review radar coverage capabilities and requirements

• SSP-13 Verify hardware processing and operations limits

• SSP-14 Determine threshold for critical orbiter impacts requiring repair

• SSP-15 Identify and implement improvements in problem tracking, and in-flight anomaly disposition



Return to Flight Process



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Implementing the Return to Flight Process

• NASA has made considerable progress toward returning safely to flight

• The week of April 12, 2004, NASA presented the first four of 15 RTF actions to the Stafford Covey Task Group for closure

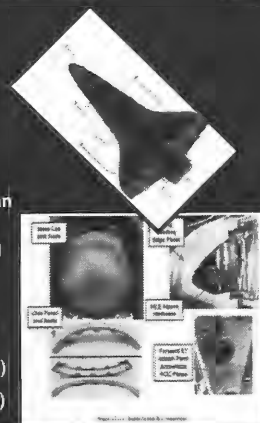
- 3.3-1, Comprehensive inspection plan for RCC (closed)

- 3.3-2, Plan for Orbiter hardening and debris transport analysis (open)

- RTFTG approved plan but left action open pending further test data

- 4.2-3, Two-person closeouts (closed)

- 6.3-2, Use of national assets (closed)





Return to Flight Status Overview

- **Eliminating External Tank Critical Debris**
 - Bipod Foam Ramp Redesign
 - Feedline Bellows Redesign
 - Intertank Flange Critical Debris Mitigation
- **Ensuring Orbiter Flight Readiness**
 - RCC Inspection/Installation
 - Wire and Flex Hose Inspections
 - Rudder Speed Brake Actuators
 - Non-Destructive Evaluations (NDE)
- **Adding Capabilities to Improve Safety**
 - Debris Transport Analysis
 - Orbiter Hardening
 - TPS inspection and damage sensors
 - Tile and RCC Repair
 - Improved Ascent and On-Orbit Imagery
 - Enhanced systems engineering and integration centralized in new Shuttle Program Office
 - Mission Management Team Training



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External Tank Critical Debris Elimination (R3.2-1)

NASA is eliminating critical debris from the External Tank

- Bipod Ramp Redesign to eliminate foam loss
- Feedline Bellows Drip Lip to prevent ice formation
- Improved LH2/intertank flange closeouts to prevent foam loss
 - NASA now understands the failure mechanism in the Intertank area
 - We have expanded the critical debris zone and reduced allowable debris size
 - Implementing a redundant solution
 - three step manual close out to eliminate voids and seal nitrogen leak paths
 - volume fill to eliminate nitrogen formation in the intertank area
- PAL Ramp and TPS verification reassessment and non-destructive inspection of foam



Rudder Speed Brake Actuators (SSP-11)

- A good example of rigorous inspections detecting “unknown unknowns”
- During the OV-104 Orbiter Maintenance Down Period in 2002, corrosion was found on the Orbiter’s Body Flap actuators; similar corrosion was also found on OV-103.
- The Shuttle Program initiated a “raising the bar” action (SSP-11) to inspect all of the Rudder Speed Brake (RSB) actuators, which are made of similar materials and exposed to similar stresses.



Rudder Speed Brake Actuators 1 through 4



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Rudder Speed Brake Actuators (cont.)

- All four RSB actuators on OV-103 had corrosion and were returned to the vendor for further inspection and refurbishment.
 - One of the actuators had a reversed planetary gear
 - The reversed gear posed a potential safety risk
- As a result, NASA decided to inspect the RSB actuators in all three Orbiters to determine if there were other reversed gears.
- These inspections, along with our work to eliminate critical ET debris, had a significant impact on our ability to meet the planned fall 2004 return to flight date.

Results

The SSP is inspecting and replacing or refurbishing as necessary all RSB actuators on all of the Orbiters prior to their first flight.



Thermal Protection System Tile Repair (R6.4-1)

- NASA has made significant progress in developing a certifiable TPS tile repair capability
- This capability will be demonstrated on STS-114
- Space Station Remote Manipulator System (SSRMS) and Shuttle Remote Manipulator System (SRMS) operations have been developed that will allow access to all parts of the TPS for repair while the Shuttle is docked to the ISS
- RCC repair is still in the concept definition phase, but significant progress has been made



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Return To Flight Summary

- NASA accepts the CAIB findings and is complying with the recommendations
- We are “raising the bar” and completing additional actions deemed necessary to ensure a safe return to flight and continued safe operations of the Shuttle
- Currently, our return to flight is scheduled for no earlier than March 2005
- We will continue to be milestone-driven and will launch STS-114 only when we have completed our goals and established that it is safe to return to flight

Find the Problem, Fix It, and Return to Safe Flight

Backup Charts

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Accepted Risk Definition

- An "accepted risk" is a hazard for which the controls for one or more of its causes do not meet the hazard reduction requirements established by the Space Shuttle Program. As a result, there is the possibility that the hazard could occur during the life of the program.
- Acceptance rationale must be formally documented and the risks must be reevaluated periodically to insure that (1) assumptions have not changed, and (2) environment or conditions have not changed.

(ref. NSTS 22254, "Methodology for Conduct of Space Shuttle Hazard Analysis" and JSC 8000.4, "JSC Risk Management")

[Return to Presentation](#)